

DIGITAL AMBIENT LIGHT SENSOR

Description

SDF-DALS-Z1 is a light to digital converter which combines photodiodes, current amplifiers, analog circuit and digital signal processor.

Ambient light sensor (ALS) built-in an optical filter for IR rejection, and providing a spectrum which is close to the human eye's response. ALS can work from dark to direct sunlight, the selectable detect range is about 40dB. Dual-channel output (human eye), so it has excellent light ratio under different light conditions. ALS has excellent light ratio under different light conditions.

SDF-DALS-Z1 has programmable interrupt function with high / low threshold.

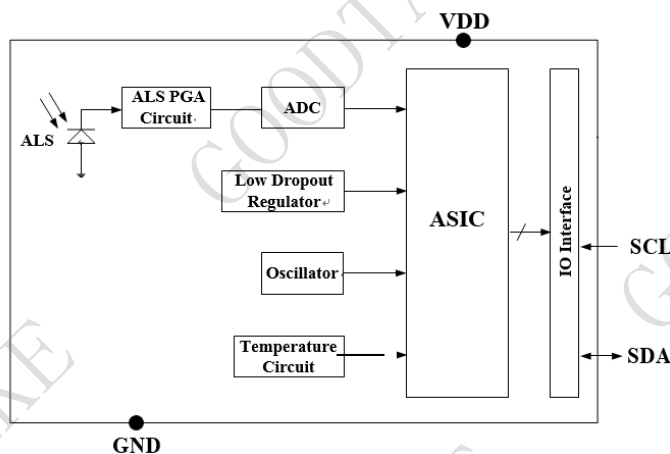
Features

- I²C interface (Fast Speed Mode at 400kHz/s)
- Supply Voltage Range from 1.7V to 3.6V
- Operating Temperature Range from -40°C to +85°C
- Ambient Light Photo Sensor
 - Close to human eyes responsibility
 - Up to 16-bit Digital Output (0~65535)
 - Programmable Dynamic Range Ratio = x1: x2:x 4: x8:x16:x32: x64.
 - Linear Output Code for Dynamic Range Selection
 - Eliminate 50 / 60 Hz Filter by Programmable Integrated Time
 - Fluorescent light flicker immunity
- SMD small form factor (3.0 mm x6.8 mm x2.35 mm Thick)
- RoHS compliant
- Floor life: 72 h, MSL 4, according to J-STD-020

Applications

- Cell Phone and LCD display backlight control
- Notebook/Monitor Security
- Automatic Menu Pop
- Digital Camera light meter

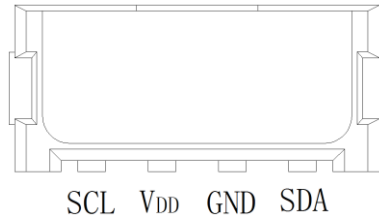
Function Block Diagram



Ordering Information

PART NUMBER	PACKING	PACKAGE	SINGLE WEIGHT	QTY/REEL
SDF-DALS-Z1	Tape and Reel Dry Pack (MSL 4)	3x6.8x2.35mm	0.0673g	2000

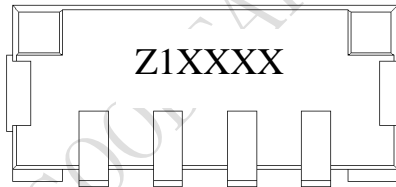
Terminals Description



Pin Description

Pin Name	I/O Type	Description
VDD		Digital/Analog Power Supply
SDA	I/O	I ² C serial date signal (open drain)
GND		Ground
SCL	I	I ² C serial clock signal (open drain)

Markings



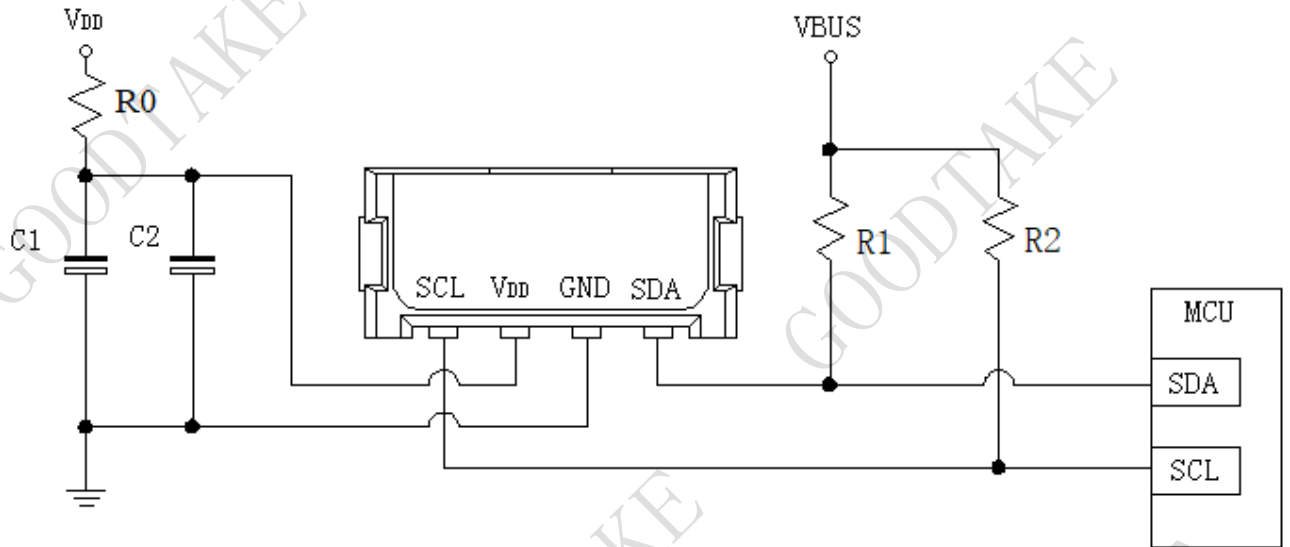
Laser marking on back side of package body

“Z1XXXX”

Z1: abbreviation of product type

XXXX:Production batch code

Typical Application Circuit



Application Circuit Design

The pull-up resistors R0 are required, 200Ω resistors can be used.

The capacitors (C1, C2) are required for power supply. The capacitors should be placed as close as possible to the device. The high frequency AC noises can be shunted to the ground by the capacitors. The transient current caused by digital circuit switching also can be handled by the capacitors. A typical value 0.1 / 4.7μF can be used.

The pull-up resistors (R1, R2) are required for I²C communication. At fast speed mode (400kHz/s) and VBUS = 3V, 1.5kΩ resistors can be used.

Absolute Maximum Ratings

Parameter	Symbol	Value	Unit
Supply Voltage	VDD	+4.5	V
I ² C Bus Pin Voltage	SCL, SDA	-0.2 to +4.5	V
I ² C Bus Pin Current	SCL, SDA	10	mA
ESD Rating, HBM	HBM	2	KV
ESD Rating, Latch-up @ TOP = 25 °C	ILU	200	mA
Operating Temperature	TOP	-40 to +85	°C
Storage Temperature	TSTG	-40 to +100	°C

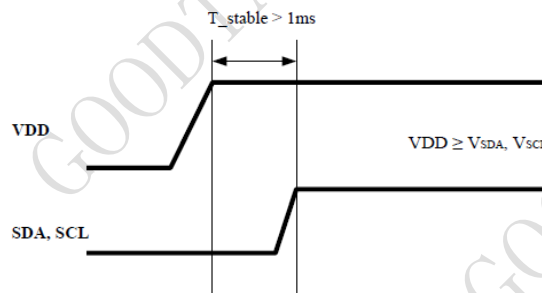
Note: Exceeding these ratings could cause damage to the device. All voltages are with respect to ground. Currents are positive into, negative out of the specified terminal.

Recommended Operation Conditions

Description	Symbol	Min.	Typ.	Max.	Unit	Condition
Supply Voltage ^{Note1,2}	V _{DD}	1.7		3.6	V	
I ² C Bus Pin Voltage ^{Note2}	V _{Bus}		VDD		V	V _{Bus} =V _{DD}
Operating Temperature	T _{ope}	-40		+85	°C	
I ² C Bus Input High Voltage	V _{IH_SCL} , V _{IH_SDA}	VDD *0.7			V	
I ² C Bus Input Low Voltage	V _{IL_SCL} , V _{IL_SDA}			0.4	V	
I ² C Bus Output Pin Low Voltage	V _{OL_SDA}	0		0.4	V	3mA sinking current
		0		0.6	V	6mA sinking current
		0		0.4	V	3mA sinking current

Notes:

1. The power supply need to make sure the VDD slew rate at least 0.5V/ms. WH81116UC have power on reset function. When VDD drops below 1.4V under room temp, the IC will be reset automatically. Then power back up at the requirement slew rate, and write registers to the desired values
2. The IC power supply sequence is shown in below
3. The specs are defined under VDD=3.3V, T=25 °C



Electrical & Optical Specifications

Unless otherwise specified, the following specifications apply over the operating ambient temperature T=25°C, VDD = 3.3V, and measure the output current by white light LED.

Electrical Characteristics	Symbol	MIN	TYP	MAX	Notes	Unit
Active Supply Current	I _{DD1}		39		Ev=0 , Note 1	μA
	I _{DD2}		7		Ev=0 , Note 2	μA
	I _{PD}		1.5		Sleepmode,Ev=0, Brownoutdisable	μA
Device Boot Time	T _{boot}		20		Note 3	ms

Notes :

1. ALSCONV=1, INTE_TIME=64, WUNIT=1T(8ms), WSTEP=64

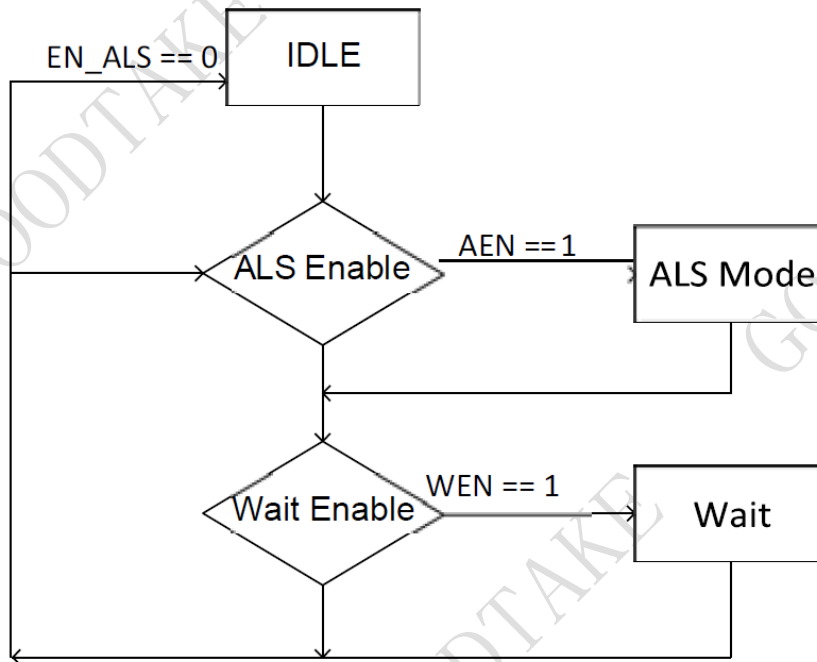
2. ALSCONV=1, INTE_TIME=64, WUNIT=8T(64ms), WSTEP=62

3. The Device Boot Time (T_{boot}) is the delay time that the host can send the first I2C command after the VDD ready

ALS Characteristics	Symbol	MIN	TYP	MAX	Notes	Unit
Sensing Gain, relative to x1 setting	AGAIN		1/4/16/64			
ALS ADC integration time step size			1.17			ms
ALS ADC numberof integration unit	ALSCONV	1		16		unit
ALS ADC numberof integration steps	INTE_TIME	1		64		step
Full scale ADC counts per step				1023		count
Full scale ADC counts value				65535		count
Dark count(white LED, Ev=0 lux)	ALS_L		0	5	AGAIN=x1 INT_TIME=0x3 ALSCONV=0x5	count
ALS ADC count value (white LED , Ev=100lux)	ALS_L		105		AGAIN=x1 INT_TIME=0x3 ALSCONV=0x5	count
Digital resolution (LSB count)			0.0069		AGAIN=x64 INT_TIME=0x3 ALSCONV=0xf	lx/step
Detectable minimum illuminance	EV min.		0.0138		AGAIN=x64 INT_TIME=0x3 ALSCONV=0xf	lx
Detectable maximum illuminance	EV max.		23423		AGAIN=x1 INT_TIME=0x3 ALSCONV=0xf	lx

State Machine

There is one prime operation mode ALS. The state machine is shown below:



Typical Characteristic Curves

Unless otherwise specified, the following specifications apply over the operating ambient temperature $T = 25^{\circ}\text{C}$, $VDD = 3.3\text{V}$.

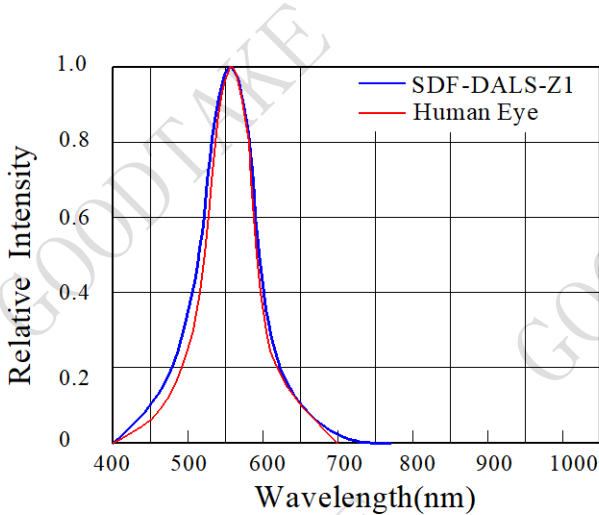


Fig.1 Spectral intensity

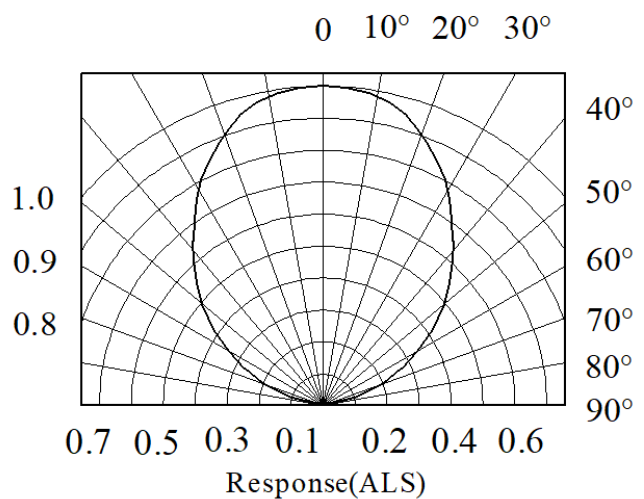
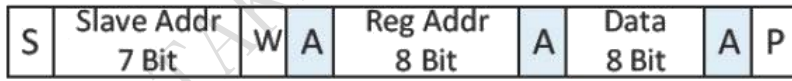


Fig.2 Angle Vs Response

I²C INTERFACE

I²C Write Format



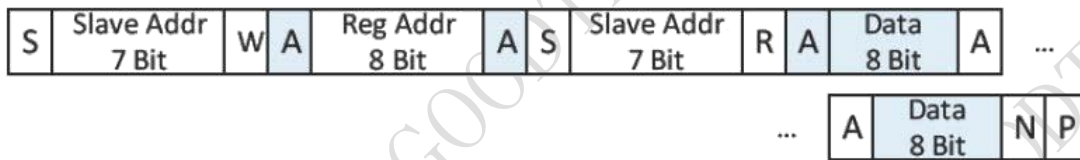
I²C Block Write Format



I²C Read Format



I²C Block Read Format



- Master to Slave
- Slave to Master
- S Start Condition, 1 Bit
- P Stop Condition, 1 Bit
- W Write, Set 0 for write, 1 Bit
- R Read, Set 1 for read, 1 Bit
- A Acknowledge(ACK), Set 0, 1 Bit
- N Non acknowledge(NACK), Set 1, 1 Bit

I²C Slave Address and R/W bit

This address is seven bits long followed by an eighth bit which is a data direction bit (R/W). A '0' indicates a transmission (WRITE), a '1' indicates a request for data (READ). The slave address of this device is 0x38.

Register Set

The SDF-DALS-Z1 is operated over the I²C bus with registers that contain configuration, status, and result information. All registers are 8 bits long. -

Address	Name	Type	Default value	Description
0x00	SYSM_CTRL	R/W	0x00	ALS/PS/CALIB operation mode control, waiting mode control, SW reset
0x03	WAIT_TIME	R/W	0x00	Waiting time setting
0x04	ALS_GAIN	R/W	0x00	ALS analog gain setting
0x05	ALS_TIME	R/W	0x03	ALS integrated time setting
0x0B	PERSISTENCE	R/W	0x01	ALS persistence setting
0x17	DATA_STATUS	R/W	0x00	Data status
0x1E	ALS_DATA_L	R	0x00	ALS channel output data - LSB
0x1F	ALS_DATA_H	R	0x00	ALS channel output data - MSB
0xBC	PROD_ID_L	R	0x11	Product ID - LSB
0xBD	PROD_ID_H	R	0x10	Product ID - MSB

0x00 SYSM_CTRL

0x00	SYSM_CTRL, System Control (Default = 0x00)							
BIT	7	6	5	4	3	2	1	0
R/W	SWRST	EN_WAIT	EN_FRST	0	0	0	EN_ONCE	EN_ALS

SWRST : Software reset. Reset all register to default value.

0: (Default)

1: Reset will be triggered.

EN_WAIT : Waiting time will be inserted between two measurements.

0: Disable waiting function. (Default)

1: Enable waiting function.

EN_FRST :

0: Enable (Brown out Reset circuit enable). (Default)

1: Disable (Brown out Reset circuit disable).

EN_ONCE = Enables ALS function once.

0: Disable ALS function. (Default)

1: Enable ALS function.

EN_ALS : Enables ALS function.

0: Disable ALS function. (Default)

1: Enable ALS function

0x03 WAIT_TIME

0x03	WAIT_TIME, waiting time (Default = 0x00)							
BIT	7	6	5	4	3	2	1	0
R/W	WTIME_UNIT			WTIME				

WTIME_UNIT = This register controls the waiting time unit of waiting state which is inserted between any two measurements. It is 8 ms per time unit.

- 0x0: 1 time unit. (Default)
- 0x1: 2 time units.
- 0x2: 4 time units.
- 0x3: 8 time units.

WTIME_STEP = This register controls the time step of waiting state. It is increase one WTIME_UNIT per step.

- 0x00: 1 WTIME_UNIT. (Default)
- 0x01: 2 WTIME_UNIT.
-
- 0x3f: 64 WTIME_UNIT.

Total waiting time = **WTIME_STEP x WTIME_UNIT**

0x04 ALS_GAIN

0x04	ALS_GAIN, ALS analog gain (Default = 0x01)							
BIT	7	6	5	4	3	2	1	0
R/W	PD_SEL	0	0					PGA_ALS

PD_SEL = PD gain select.

- 0x00: x1 (Default)
- 0x01: x2

PGA_ALS = ALS sensing gain.

- 0x01: x1 (Default)
- 0x02: x4
- 0x04: x16
- 0x08: x64

0x05 ALS_TIME

0x05	ALS_TIME, ALS integrated time (Default = 0x03)							
BIT	7	6	5	4	3	2	1	0
R/W	ALSCONV				0	0	INT_TIME	

ALSCONV : This register controls the conversion time of AD converter at ALS mode (T_{ALS}), and the resolution of output dat.

0x0: $T_{ALS} = 1 * INT_TIME$ (Default)

0x1: $T_{ALS} = 2 * INT_TIME$

.....
0xf: $T_{ALS} = 16 * INT_TIME$

INT : **NOTE: recommended to use the maximum $T_{ALS}(0xf)$.**

0x0: $INT_TIME (T) = 1.171 \text{ ms}$, the maximum count of **output data is** 1023.

0x1: $INT_TIME (4T) = 4.683 \text{ ms}$, the maximum count of **output data is** 4095.

0x2: $INT_TIME (16T) = 18.731 \text{ ms}$, the maximum count of **output data is** 16383.

0x3: $INT_TIME (64T) = 74.923 \text{ ms}$, the maximum count of **output data is** 65535. (Default)

The conversion time of ALS function (T_{ALS}) is decided by **ALSCONV and INT_TIME**.

$$T_{ALS} = INT_TIME \times (ALSCONV + 1) \quad (\text{ms})$$

EX:

Setting $INT_TIME = 0x01$ (4T UNIT) and $ALSCONV = 0x01$

The maximum count of **output data is** minimum of

$$[1024 \times [INT_TIME * (ALSCONV + 1)] - 1, 65535]$$

$$= [1024 \times [4 * (1 + 1)] - 1, 65535].$$

0x0B PERSISTENCE

0x0B	PERSISTENCE, ALS persistence setting (Default = 0x01)							
BIT	7	6	5	4	3	2	1	0
R/W	0			INT_SRC	PRS_ALS			

INT_SRC : **This register sets to select the ALS data for the ALS Interrupt algorithm.**

0x00: Select ALS_DATA. (Default)

0x01: Select COMP_DATA.

0x17 DATA_STATUS

0x17	DATA_STAT_0, Data status							
BIT	7	6	5	4	3	2	1	0
R	DATA_REDY	0	0	0	0	0	SAT_ALS	SAT_COMP

This register indicates the ALS data status.

The data ready flag will set to one when the data register is updated. After read the data register, the data ready flag will clear to zero.

If the ALS data is outside of measurable range, the corresponding saturation flag will set to one. That means the data is invalid.

0x1E/0x1F ALS_DATA

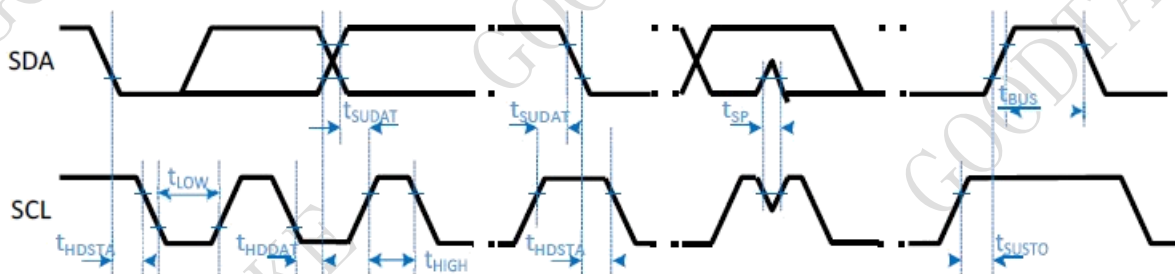
0x1E 0x1F	ALS_DATA, ALS channel output data.							
BIT	7	6	5	4	3	2	1	0
R	ALS_DATA_L							
R	ALS_DATA_H							

The result of ALS sensor is written into ALS_DATA when ALS conversion is done.

For insuring the data in the register comes the same measurement, the high byte data will be latched when the low byte data has being accessed until the high byte data has be read..

I²C Interface Timing Characteristics

This section will describe the protocol of the I²C bus. For more details and timing diagrams please refer to the I²C specification.



Parameter (*)	Symbol	Fast mode		Unit
		Min	Max	
SCL clock frequency	f_{SCL}	100	400	kHz
Bus free time between STOP condition and START condition	t_{BUS}	1.3	--	μs
LOW period of the SCL clock	t_{LOW}	1.3	--	μs
HIGH period of the SCL clock	t_{HIGH}	0.6	--	μs
Hold time (repeated) START condition	t_{HDSTA}	0.6	--	μs
Set-up time (repeated) START condition	t_{SUSTA}	0.6	--	μs
Set-up time for STOP condition	t_{SUSTO}	0.6	--	μs
Data hold time	t_{HDDAT}	50	--	ns
Data set-up time	t_{SUDAT}	100	--	ns
Pulse width of spikes which must be suppressed by the input filter	t_{SP}	0	50	ns
Rise time of both SDA and SCL signals		20 x VDD/5.5	300	ns
Fall time of both SDA and SCL signals		20 x VDD/5.5	300	ns

(*) Specified by design and characterization; not production tested.

(**) All specifications are at $V_{BUS} = 3.3V$, $T_{ope}=25^{\circ}C$, unless otherwise noted.

Note:

I²C Bus Clear

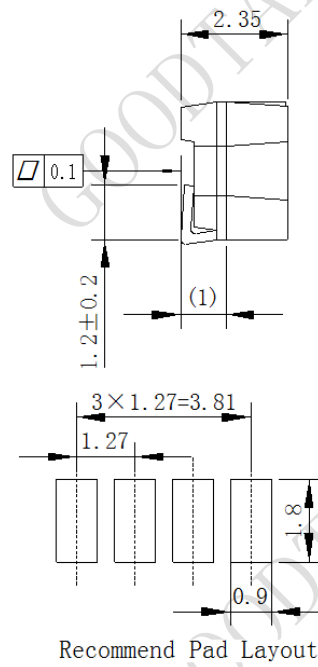
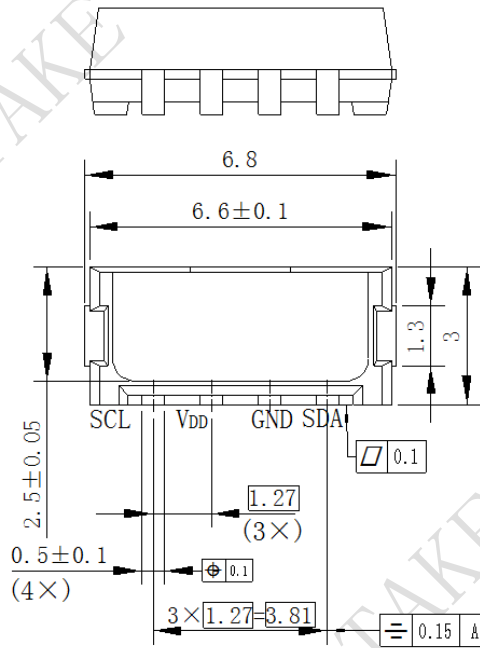
The standard I²C communication method is applied for the ambient light sensor with the host CPU. The complete communication period need 9 SCL periods. When accident occurs so that interrupt is forced, i.e. SCL period is less than 9, the SDA of device will lock up. And SDA will be always a high or low level state to wait for the SCL clock. In the moment powdering off and reinitializing is necessary or SCL period is not less than 9, these ways can help device finish the current operation and recover standby to complete the subsequent read and write operations.

I²C General Call Software Reset

Following a General Call, (0000 0000), sending 0000 0110 (06h) as the second byte causes software reset. This feature is optional and not all devices will respond to this command. On receiving this 2- byte sequence, all devices designed to respond to the general call address will reset and take in the programmable part of their address.

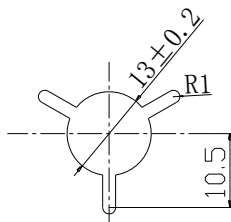
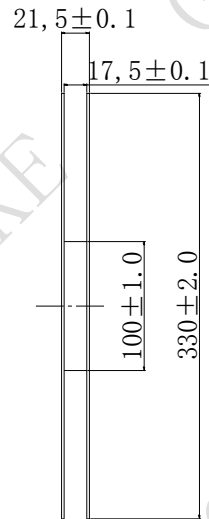
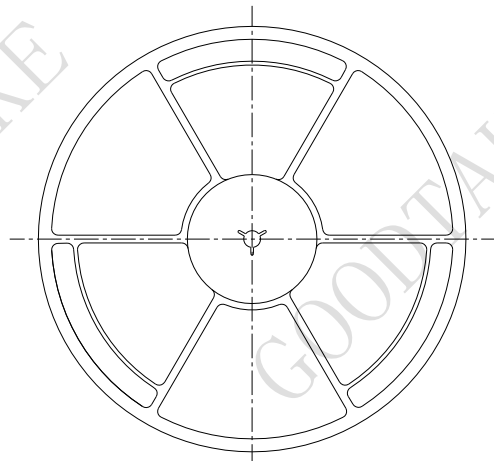
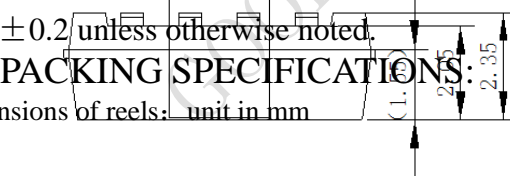
Precautions have to be taken to ensure that a device is not pulling down the SDA or SCL line after applying the supply voltage, since these low levels would block the bus.

■ Package Outline Dimensions: All dimensions are in mm

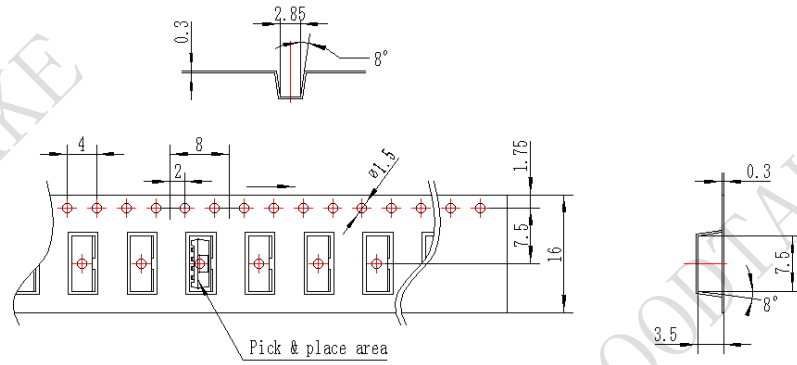


NOTE: Tolerance is ± 0.2 unless otherwise noted.
TAPPING AND PACKING SPECIFICATIONS:

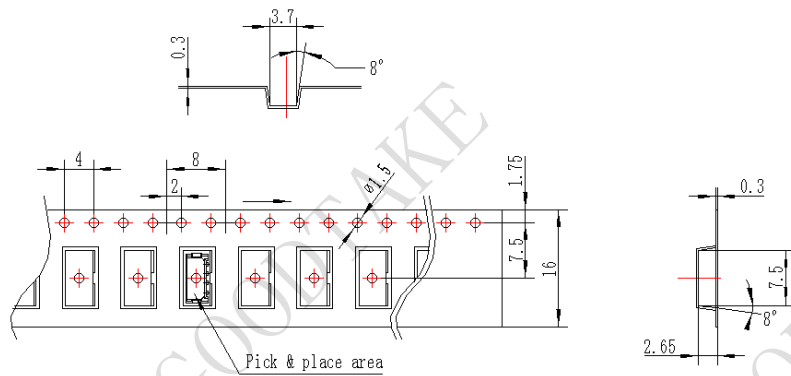
(1) Shape and dimensions of reels: unit in mm



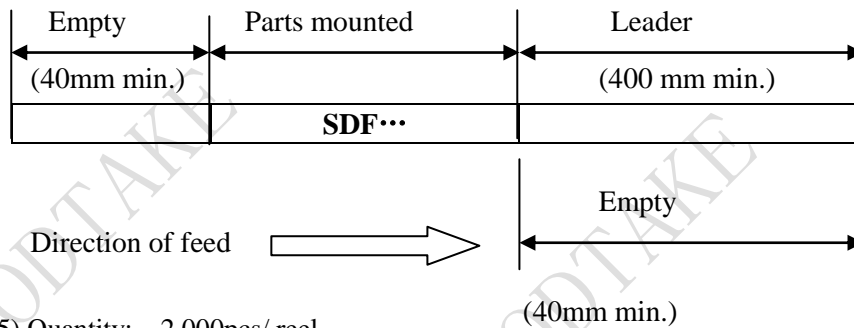
(2) Dimensions of TR tape



(3) Dimensions of TT tape

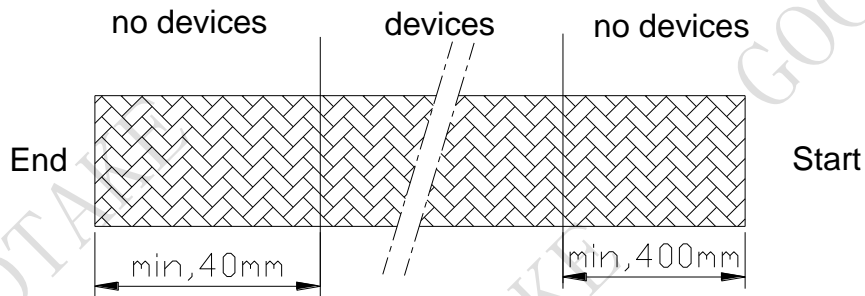


(4) Configuration of tape

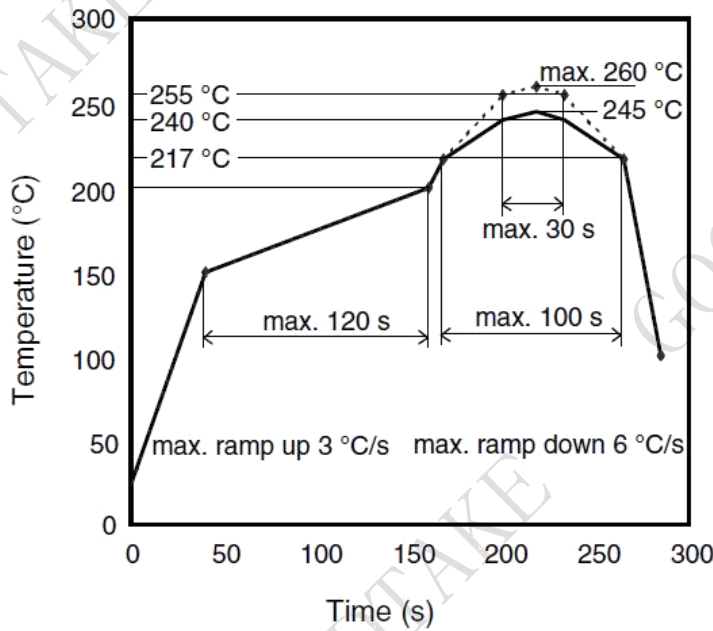


(5) Quantity: 2,000pcs/ reel

Leader and Trailer Dimensions



Reflow Soldering Profile



Antistatic Dry Pack

Opto devices in SMD package may be sensitive to moisture. Devices are taped & reeled, sealed in antistatic bag with silica gel desiccants.

Do not open the sealed moisture-proof bag before ready to use. If sealing is void, baking treatment may be required.

Storage

Shelf life – Devices should be stored in its original packing, in a controlled environment of temperature less than 40 °C and relative humidity below 90%.

Suggested shelf life is 12 months in its original packing.

Floor life – 72 hours in controlled environment, $T_{amb} < 30\text{ °C}$, $RH < 60\%$. Time between soldering and removing from moisture barrier bags must not exceed the time indicated in J-STD-020.

Moisture Sensitive Level classification: LEVEL 4

Drying (Baking Process)

If original packing is voided (such as faded silica gel or exceeded storage time), baking treatment should be performed with the following conditions: $T_{bake} = 40 \pm 5\text{ °C}$, $RH < 5\%$, Time = 192 hours.